Swing Programming Part 1

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Introduction to Graphics

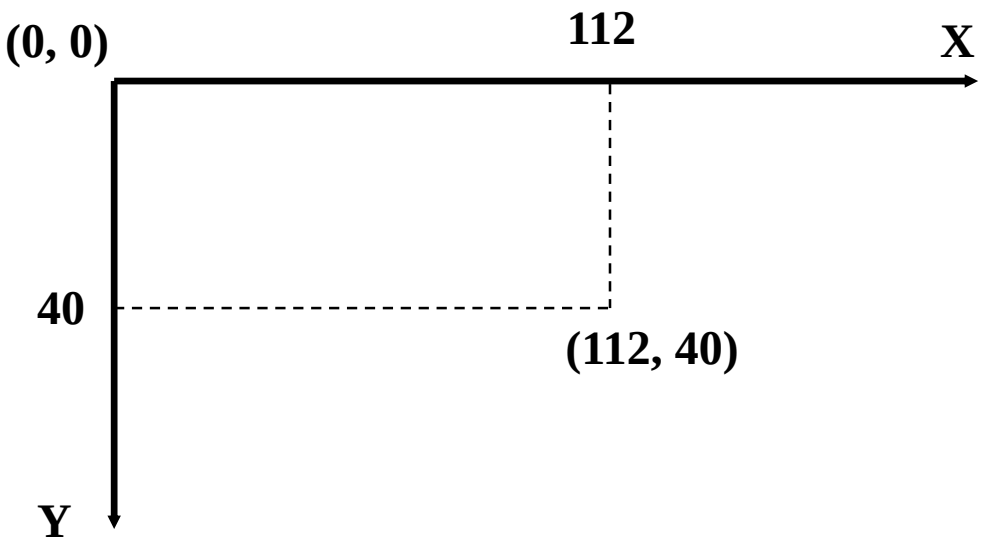
- The last few sections of each chapter of the textbook focus on graphics and graphical user interfaces
- A picture or drawing must be digitized for storage on a computer
- A picture is made up of *pixels* (picture elements), and each pixel is stored separately
- The number of pixels used to represent a picture is called the *picture resolution*
- The number of pixels that can be displayed by a monitor is called the *monitor resolution*

Representing Images

- A digitized picture with a small portion magnified:

Coordinate Systems

- Each pixel can be identified using a two-dimensional coordinate system
- When referring to a pixel in a Java program, we use a coordinate system with the origin in the top-left corner



Representing Color

- A black and white picture could be stored using one bit per pixel (0 = white and 1 = black)
- A colored picture requires more information; there are several techniques for representing colors
- Every color can be represented as a mixture of the three additive primary colors Red, Green, and Blue
- Each color is represented by three numbers between 0 and 255 that collectively are called an *RGB value*

The Color Class

- A color in a Java program is represented as an object created from the `Color` class

- The `Color` class also contains several predefined colors, including the following:

Object	RGB Value
`Color.black`	`0, 0, 0`
`Color.blue`	`0, 0, 255`
`Color.cyan`	`0, 255, 255`
`Color.orange`	`255, 200, 0`
`Color.white`	`255, 255, 255`
`Color.yellow`	`255, 255, 0`

GUI Components

- A *GUI component* is an object that represents a screen element such as a button or a text field
- GUI-related classes are defined primarily in the `java.awt` and the `javax.swing` packages
- The *Abstract Windowing Toolkit* (AWT) was the original Java GUI package
- The *Swing* package provides additional and more versatile components
- Both packages are needed to create a Java GUI-

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GUI Containers

- A *GUI container* is a component that is used to hold and organize other components
- A *frame* is a container displayed as a separate window with a title bar
- It can be repositioned and resized on the screen as needed
- A *panel* is a container that cannot be displayed on its own but is used to organize other components
- A panel must be added to another container (like a frame or another panel) to be displayed

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GUI Containers

- A GUI container can be classified as either heavyweight or lightweight
- A *heavyweight container* is one that is managed by the underlying operating system
- A *lightweight container* is managed by the Java program itself
- Occasionally this distinction is important
- A frame is a heavyweight container and a panel is a lightweight container

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Labels

- A *label* is a GUI component that displays a line of text and/or an image
- Labels are usually used to display information or identify other components in the interface
- Let's look at a program that organizes two labels in a panel and displays that panel in a frame
- This program is not interactive, but the frame can be repositioned and resized
- See `Authority.java`

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```
//********************************************************************
//  Authority.java       Author: Lewis/Loftus
//
//  Demonstrates the use of frames, panels, and labels.
//********************************************************************

import java.awt.*;
import javax.swing.*;

public class Authority
{
   //-----------------------------------------------------------------
   //  Displays some words of wisdom.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Authority");

      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      JPanel primary = new JPanel();
      primary.setBackground(Color.yellow);
      primary.setPreferredSize(new Dimension(250, 75));
```

continued

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continued

```
        JLabel label1 = new JLabel("Question authority,");
        JLabel label2 = new JLabel("but raise your hand first.");

        primary.add(label1);
        primary.add(label2);

        frame.getContentPane().add(primary);
        frame.pack();
        frame.setVisible(true);
    }
}
```

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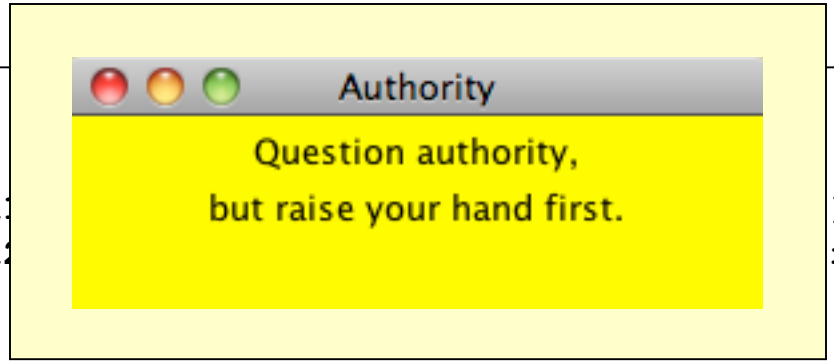
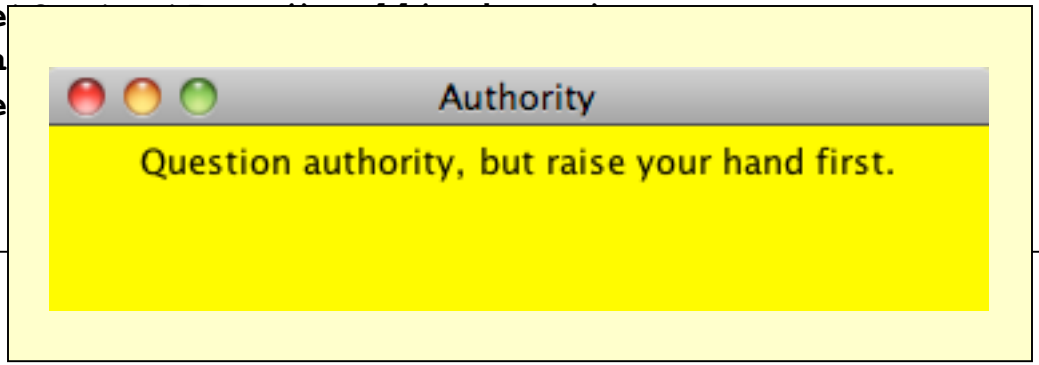
continued

```
        JLabel label1
        JLabel label2
                                                    );
                                                    first.");

        primary.add
        primary.add(label2);

        frame.ge
        frame.pa
        frame.se
    }
}
```





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Nested Panels

- Containers that contain other components make up the *containment hierarchy* of an interface
- This hierarchy can be as intricate as needed to create the visual effect desired
- The following example nests two panels inside a third panel – note the effect this has as the frame is resized
- See `NestedPanels.java`

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```
//********************************************************************
//  NestedPanels.java       Author: Lewis/Loftus
//
//  Demonstrates a basic componenet hierarchy.
//********************************************************************

import java.awt.*;
import javax.swing.*;

public class NestedPanels
{
   //-----------------------------------------------------------------
   //  Presents two colored panels nested within a third.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Nested Panels");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      // Set up first subpanel
      JPanel subPanel1 = new JPanel();
      subPanel1.setPreferredSize(new Dimension(150, 100));
      subPanel1.setBackground(Color.green);
      JLabel label1 = new JLabel("One");
      subPanel1.add(label1);
```

continued

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continued

```
        // Set up second subpanel
        JPanel subPanel2 = new JPanel();
        subPanel2.setPreferredSize(new Dimension(150, 100));
        subPanel2.setBackground(Color.red);
        JLabel label2 = new JLabel("Two");
        subPanel2.add(label2);

        // Set up primary panel
        JPanel primary = new JPanel();
        primary.setBackground(Color.blue);
        primary.add(subPanel1);
        primary.add(subPanel2);

        frame.getContentPane().add(primary);
        frame.pack();
        frame.setVisible(true);
    }
}
```

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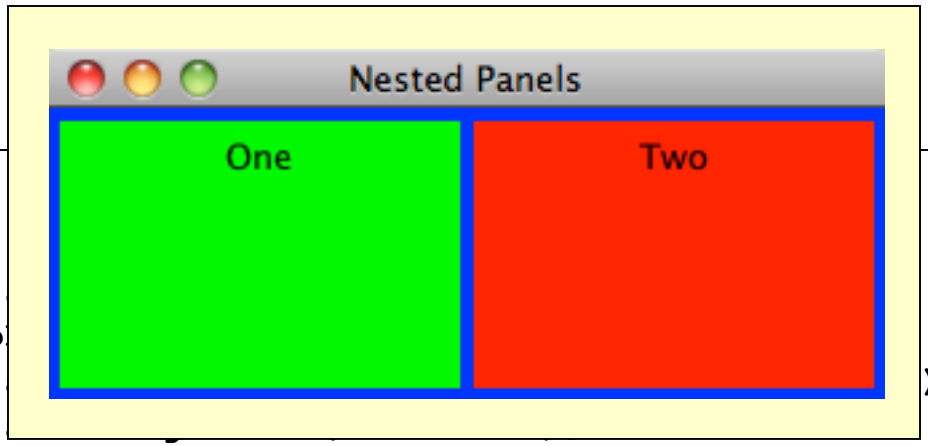
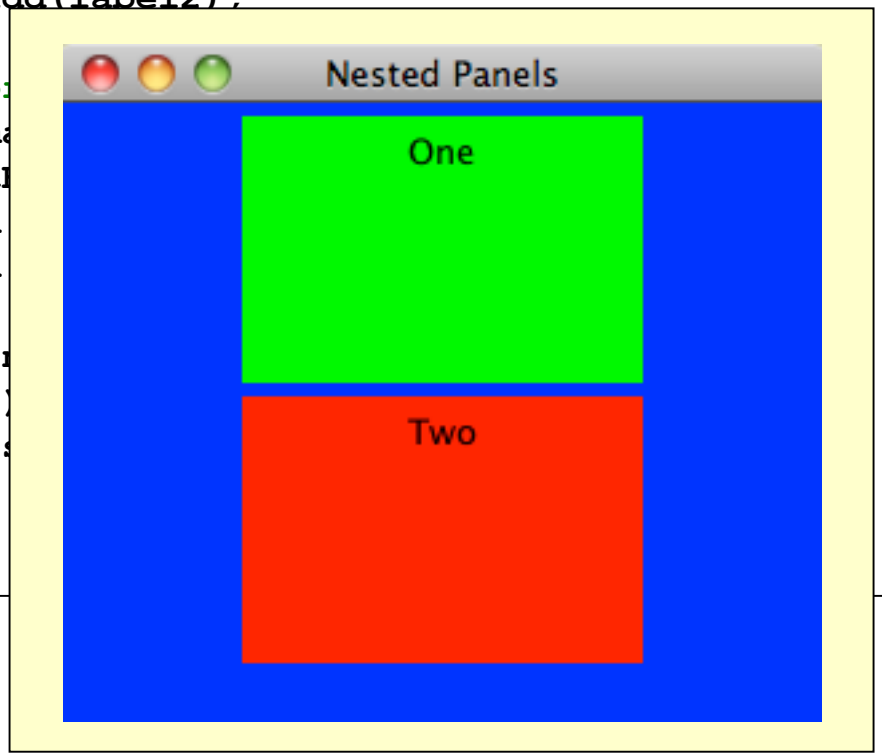


continued

```
        // Set up
        JPanel sub
        subPanel2.                                          );
        subPanel2.
        JLabel label2 = new JLabel("Two");
        subPanel2.add(label2);

        // Set up pr
        JPanel prima
        primary.setL
        primary.add
        primary.add

        frame.getCo
        frame.pack()
        frame.setVis
    }
}
```



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Outline

- Creating Objects
- The String Class
- The Random and Math Classes
- Formatting Output
- Enumerated Types
- Wrapper Classes
- Components and Containers
- Images

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Images

- Images can be displayed in a Java program in various ways
- As we've seen, a `JLabel` object can be used to display a line of text
- It can also be used to display an image
- That is, a label can be composed of text, an image, or both at the same time

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Images

- The `ImageIcon` class is used to represent the image that is stored in a label
- If text is also included, the position of the text relative to the image can be set explicitly
- The alignment of the text and image within the label can be set as well
- See `LabelDemo.java`

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```
//********************************************************************
//  LabelDemo.java       Author: Lewis/Loftus
//
//  Demonstrates the use of image icons in labels.
//********************************************************************

import java.awt.*;
import javax.swing.*;

public class LabelDemo
{
   //-----------------------------------------------------------------
   //  Creates and displays the primary application frame.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Label Demo");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      ImageIcon icon = new ImageIcon("devil.gif");

      JLabel label1, label2, label3;

      label1 = new JLabel("Devil Left", icon, SwingConstants.CENTER);
```

continued

continued

```
        label2 = new JLabel("Devil Right", icon, SwingConstants.CENTER);
        label2.setHorizontalTextPosition(SwingConstants.LEFT);
        label2.setVerticalTextPosition(SwingConstants.BOTTOM);

        label3 = new JLabel("Devil Above", icon, SwingConstants.CENTER);
        label3.setHorizontalTextPosition(SwingConstants.CENTER);
        label3.setVerticalTextPosition(SwingConstants.BOTTOM);

        JPanel panel = new JPanel();
        panel.setBackground(Color.cyan);
        panel.setPreferredSize(new Dimension(200, 250));
        panel.add(label1);
        panel.add(label2);
        panel.add(label3);

        frame.getContentPane().add(panel);
        frame.pack();
        frame.setVisible(true);
    }
}
```

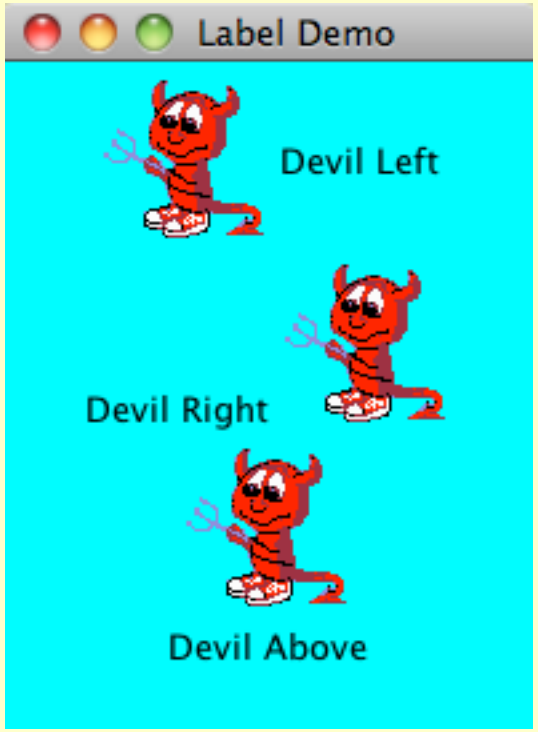
continued

```
        label2 = new JL                                    ingConstants.CENTER);
        label2.setHori                                     ants.LEFT);
        label2.setVerti                                    ts.BOTTOM);

        label3 = new JL                                    ingConstants.CENTER);
        label3.setHori                                     ants.CENTER);
        label3.setVerti                                    ts.BOTTOM);

        JPanel panel =
        panel.setBackg
        panel.setPrefe                                     250));
        panel.add(label
        panel.add(label
        panel.add(label

        frame.getContentPane().add(panel);
        frame.pack();
        frame.setVisible(true);
    }
}
```



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Graphical Objects

- Some objects contain information that determines how the object should be represented visually
- Most GUI components are graphical objects
- We can have some effect on how components get drawn
- We did this in Chapter 2 when we defined the `paint` method of an applet
- Let's look at some other examples of graphical objects

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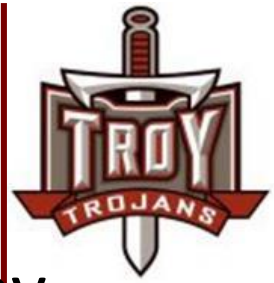
Smiling Face Example



- The `SmilingFace` program draws a face by defining the `paintComponent` method of a panel
- See `SmilingFace.java`
- See `SmilingFacePanel.java`
- The `main` method of the `SmilingFace` class instantiates a `SmilingFacePanel` and displays it
- The `SmilingFacePanel` class is derived from the `JPanel` class using inheritance

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```
//********************************************************************
//  SmilingFace.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a separate panel class.
//********************************************************************

import javax.swing.JFrame;

public class SmilingFace
{
   //-----------------------------------------------------------------
   //  Creates the main frame of the program.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Smiling Face");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      SmilingFacePanel panel = new SmilingFacePanel();

      frame.getContentPane().add(panel);

      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//************
//  SmilingFac
//
//  Demonstrat
//************

import javax.s

public class S
{
   //--------
   //  Creates
   //--------
   public stat
   {
      JFrame frame = new JFrame("Smiling Face");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      SmilingFacePanel panel = new SmilingFacePanel();

      frame.getContentPane().add(panel);

      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//********************************************************************
//  SmilingFacePanel.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a separate panel class.
//********************************************************************

import javax.swing.JPanel;
import java.awt.*;

public class SmilingFacePanel extends JPanel
{
   private final int BASEX = 120, BASEY = 60; // base point for head

   //-----------------------------------------------------------------
   //  Constructor: Sets up the main characteristics of this panel.
   //-----------------------------------------------------------------
   public SmilingFacePanel()
   {
      setBackground(Color.blue);
      setPreferredSize(new Dimension(320, 200));
      setFont(new Font("Arial", Font.BOLD, 16));
   }
```

continue

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continue

```
//-----------------------------------------------------------------
//  Draws a face.
//-----------------------------------------------------------------
public void paintComponent(Graphics page)
{
   super.paintComponent(page);

   page.setColor(Color.yellow);
   page.fillOval(BASEX, BASEY, 80, 80);  // head
   page.fillOval(BASEX-5, BASEY+20, 90, 40);  // ears

   page.setColor(Color.black);
   page.drawOval(BASEX+20, BASEY+30, 15, 7);  // eyes
   page.drawOval(BASEX+45, BASEY+30, 15, 7);

   page.fillOval(BASEX+25, BASEY+31, 5, 5);   // pupils
   page.fillOval(BASEX+50, BASEY+31, 5, 5);

   page.drawArc(BASEX+20, BASEY+25, 15, 7, 0, 180);  // eyebrows
   page.drawArc(BASEX+45, BASEY+25, 15, 7, 0, 180);

   page.drawArc(BASEX+35, BASEY+40, 15, 10, 180, 180);  // nose
   page.drawArc(BASEX+20, BASEY+50, 40, 15, 180, 180);  // mouth
```

continue

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continue

```
        page.setColor(Color.white);
        page.drawString("Always remember that you are unique!",
                        BASEX-105, BASEY-15);
        page.drawString("Just like everyone else.", BASEX-45, BASEY+105);
    }
}
```

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Smiling Face Example

- Every Swing component has a `paintComponent` method
- The `paintComponent` method accepts a `Graphics` object that represents the graphics context for the panel
- We define the `paintComponent` method to draw the face with appropriate calls to the `Graphics` methods
- Note the difference between drawing on a panel and adding other GUI components to a panel

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Splat Example

- The `Splat` example is structured a bit differently
- It draws a set of colored circles on a panel, but each circle is represented as a separate object that maintains its own graphical information
- The `paintComponent` method of the panel "asks" each circle to draw itself
- See `Splat.java`
- See `SplatPanel.java`
- See `Circle.java`

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```
//********************************************************************
//  Splat.java       Author: Lewis/Loftus
//
//  Demonstrates the use of graphical objects.
//********************************************************************

import javax.swing.*;
import java.awt.*;

public class Splat
{
   //-----------------------------------------------------------------
   //  Presents a collection of circles.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Splat");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      frame.getContentPane().add(new SplatPanel());

      frame.pack();
      frame.setVisible(true);
   }
}
```

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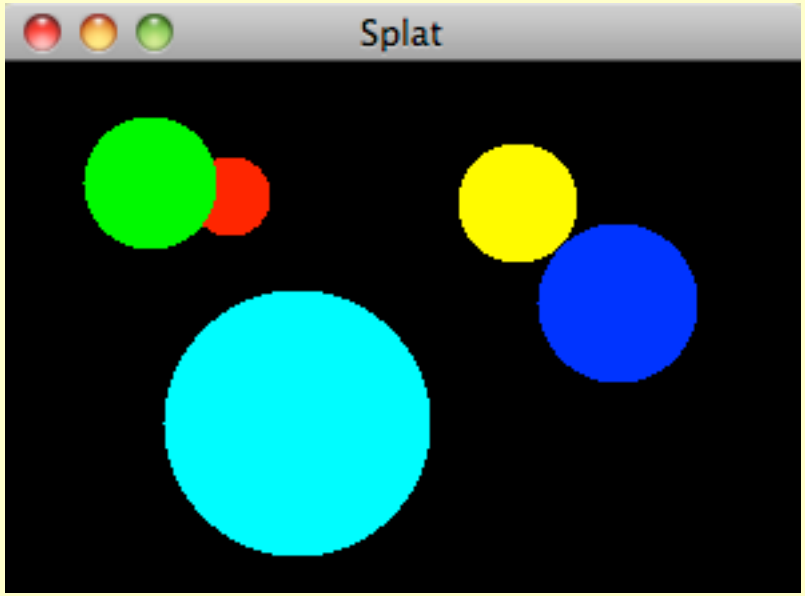
```
//*************
//  Splat.java
//
//  Demonstrate
//*************

import javax.sw
import java.awt

public class Sp
{
   //---------
   //  Presents
   //---------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Splat");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      frame.getContentPane().add(new SplatPanel());

      frame.pack();
      frame.setVisible(true);
   }
}
```



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```
//********************************************************************
//  SplatPanel.java       Author: Lewis/Loftus
//
//  Demonstrates the use of graphical objects.
//********************************************************************

import javax.swing.*;
import java.awt.*;

public class SplatPanel extends JPanel
{
   private Circle circle1, circle2, circle3, circle4, circle5;

   //-----------------------------------------------------------------
   //  Constructor: Creates five Circle objects.
   //-----------------------------------------------------------------
   public SplatPanel()
   {
      circle1 = new Circle(30, Color.red, 70, 35);
      circle2 = new Circle(50, Color.green, 30, 20);
      circle3 = new Circle(100, Color.cyan, 60, 85);
      circle4 = new Circle(45, Color.yellow, 170, 30);
      circle5 = new Circle(60, Color.blue, 200, 60);

      setPreferredSize(new Dimension(300, 200));
      setBackground(Color.black);
   }
```

continue

continue

```
    //-----------------------------------------------------------------
    //  Draws this panel by requesting that each circle draw itself.
    //-----------------------------------------------------------------
    public void paintComponent(Graphics page)
    {
        super.paintComponent(page);

        circle1.draw(page);
        circle2.draw(page);
        circle3.draw(page);
        circle4.draw(page);
        circle5.draw(page);
    }
}
```

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```
//********************************************************************
//  Circle.java       Author: Lewis/Loftus
//
//  Represents a circle with a particular position, size, and color.
//********************************************************************

import java.awt.*;

public class Circle
{
   private int diameter, x, y;
   private Color color;

   //-----------------------------------------------------------------
   //  Constructor: Sets up this circle with the specified values.
   //-----------------------------------------------------------------
   public Circle(int size, Color shade, int upperX, int upperY)
   {
      diameter = size;
      color = shade;
      x = upperX;
      y = upperY;
   }
```

continue

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continue

```
//-----------------------------------------------------------------
//  Draws this circle in the specified graphics context.
//-----------------------------------------------------------------
public void draw(Graphics page)
{
   page.setColor(color);
   page.fillOval(x, y, diameter, diameter);
}

//-----------------------------------------------------------------
//  Diameter mutator.
//-----------------------------------------------------------------
public void setDiameter(int size)
{
   diameter = size;
}

//-----------------------------------------------------------------
//  Color mutator.
//-----------------------------------------------------------------
public void setColor(Color shade)
{
   color = shade;
}
```

continue

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continue

```
//-----------------------------------------------------------------
//  X mutator.
//-----------------------------------------------------------------
public void setX(int upperX)
{
   x = upperX;
}

//-----------------------------------------------------------------
//  Y mutator.
//-----------------------------------------------------------------
public void setY(int upperY)
{
   y = upperY;
}

//-----------------------------------------------------------------
//  Diameter accessor.
//-----------------------------------------------------------------
public int getDiameter()
{
   return diameter;
}
```

continue

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continue

```
    //-----------------------------------------------------------------
    //  Color accessor.
    //-----------------------------------------------------------------
    public Color getColor()
    {
       return color;
    }

    //-----------------------------------------------------------------
    //  X accessor.
    //-----------------------------------------------------------------
    public int getX()
    {
       return x;
    }

    //-----------------------------------------------------------------
    //  Y accessor.
    //-----------------------------------------------------------------
    public int getY()
    {
       return y;
    }
}
```

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Outline

- Anatomy of a Class
- Encapsulation
- Anatomy of a Method
- Graphical Objects
- Graphical User Interfaces
- Buttons and Text Fields

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Graphical User Interfaces

- A Graphical User Interface (GUI) in Java is created with at least three kinds of objects:
  - components, events, and listeners
- We've previously discussed *components*, which are objects that represent screen elements:
  - labels, buttons, text fields, menus, etc.
- Some components are *containers* that hold and organize other components:
  - frames, panels, applets, dialog boxes

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Events

- An *event* is an object that represents some activity to which we may want to respond
- For example, we may want our program to perform some action when the following occurs:
  - the mouse is moved
  - the mouse is dragged
  - a mouse button is clicked
  - a graphical button is pressed
  - a keyboard key is pressed
  - a timer expires

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Events and Listeners

- The Java API contains several classes that represent typical events
- Components, such as a graphical button, generate (or fire) an event when it occurs
- We set up a *listener* object to respond to an event when it occurs
- We can design listener objects to take whatever actions are appropriate when an event occurs

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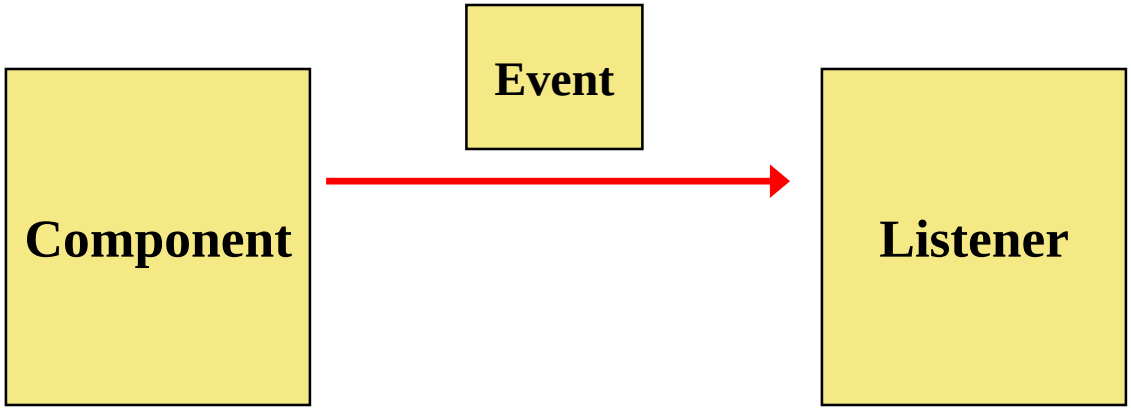
Events and Listeners



A component object generates an event

A corresponding listener object is designed to respond to the event

When the event occurs, the component calls the appropriate method of the listener, passing an object that describes the event

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GUI Development

- To create a Java program that uses a GUI we must:
  - instantiate and set up the necessary components
  - implement listener classes for any events we care about
  - establish the relationship between listeners and the components that generate the corresponding events
- Let's now explore some new components and see how this all comes together

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Outline

- Anatomy of a Class
- Encapsulation
- Anatomy of a Method
- Graphical Objects
- Graphical User Interfaces
- Buttons and Text Fields

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Buttons

- A *push button* is defined by the `JButton` class
- It generates an *action event*
- The `PushCounter` example displays a push button that increments a counter each time it is pushed
- See `PushCounter.java`
- See `PushCounterPanel.java`

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```
//********************************************************************
//  PushCounter.java       Authors: Lewis/Loftus
//
//  Demonstrates a graphical user interface and an event listener.
//********************************************************************

import javax.swing.JFrame;

public class PushCounter
{
   //-----------------------------------------------------------------
   //  Creates the main program frame.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Push Counter");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      frame.getContentPane().add(new PushCounterPanel());

      frame.pack();
      frame.setVisible(true);
   }
}
```

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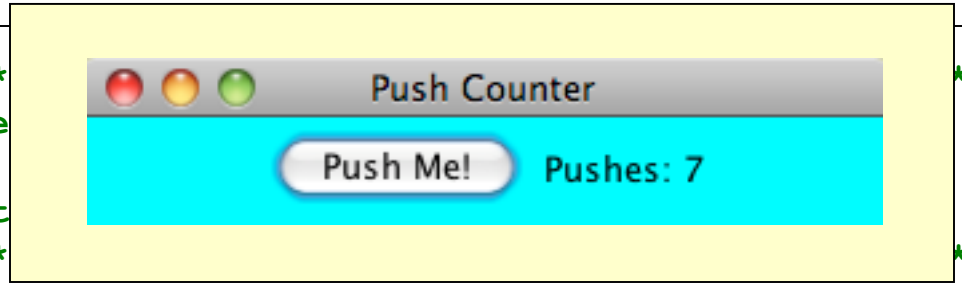


```
//*************                                              **************
//  PushCounte
//
//  Demonstrat                                               listener.
//*************                                              **************

import javax.swing.JFrame;

public class PushCounter
{
   //-----------------------------------------------------------------
   //  Creates the main program frame.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Push Counter");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      frame.getContentPane().add(new PushCounterPanel());

      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//********************************************************************
//  PushCounterPanel.java       Authors: Lewis/Loftus
//
//  Demonstrates a graphical user interface and an event listener.
//********************************************************************

import java.awt.*;
import java.awt.event.*;
import javax.swing.*;

public class PushCounterPanel extends JPanel
{
   private int count;
   private JButton push;
   private JLabel label;

   //-----------------------------------------------------------------
   //  Constructor: Sets up the GUI.
   //-----------------------------------------------------------------
   public PushCounterPanel()
   {
      count = 0;

      push = new JButton("Push Me!");
      push.addActionListener(new ButtonListener());
```

continue

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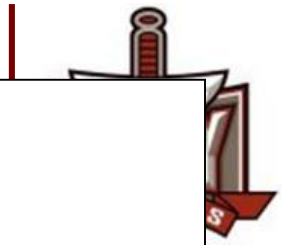

continue

```
        label = new JLabel("Pushes: " + count);

        add(push);
        add(label);

        setPreferredSize(new Dimension(300, 40));
        setBackground(Color.cyan);
    }

    //*****************************************************************
    //  Represents a listener for button push (action) events.
    //*****************************************************************
    private class ButtonListener implements ActionListener
    {
        //--------------------------------------------------------------
        //  Updates the counter and label when the button is pushed.
        //--------------------------------------------------------------
        public void actionPerformed(ActionEvent event)
        {
            count++;
            label.setText("Pushes: " + count);
        }
    }
}
```

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Push Counter Example

- The components of the GUI are the button, a label to display the counter, a panel to organize the components, and the main frame
- The `PushCounterPanel` class represents the panel used to display the button and label
- The `PushCounterPanel` class is derived from `JPanel` using inheritance
- The constructor of `PushCounterPanel` sets up the elements of the GUI and initializes the counter to zero

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Push Counter Example

- The `ButtonListener` class is the listener for the action event generated by the button
- It is implemented as an *inner class*, which means it is defined within the body of another class
- That facilitates the communication between the listener and the GUI components
- Inner classes should only be used in situations where there is an intimate relationship between the two classes and the inner class is not needed in any other context

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Push Counter Example

- Listener classes are written by implementing a *listener interface*
- The `ButtonListener` class implements the `ActionListener` interface
- An interface is a list of methods that the implementing class must define
- The only method in the `ActionListener` interface is the `actionPerformed` method
- The Java API contains interfaces for many types of events
- We discuss interfaces in more detail in Chapter 6

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Push Counter Example

- The `PushCounterPanel` constructor:
  - instantiates the `ButtonListener` object
  - establishes the relationship between the button and the listener by the call to `addActionListener`
- When the user presses the button, the button component creates an `ActionEvent` object and calls the `actionPerformed` method of the listener
- The `actionPerformed` method increments the counter and resets the text of the label

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Quick Check

Which object in the Push Counter example generated the event?

What did it do then?

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Quick Check

Which object in the Push Counter example generated the event?

The button component generated the event.

What did it do then?

It called the `actionPerformed` method of the listener object that had been registered with it.

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Text Fields

- Let's look at another GUI example that uses another type of component
- A *text field* allows the user to enter one line of input
- If the cursor is in the text field, the text field object generates an action event when the enter key is pressed
- See `Fahrenheit.java`
- See `FahrenheitPanel.java`

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```
//********************************************************************
//  Fahrenheit.java       Author: Lewis/Loftus
//
//  Demonstrates the use of text fields.
//********************************************************************

import javax.swing.JFrame;

public class Fahrenheit
{
   //-----------------------------------------------------------------
   //  Creates and displays the temperature converter GUI.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Fahrenheit");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      FahrenheitPanel panel = new FahrenheitPanel();

      frame.getContentPane().add(panel);
      frame.pack();
      frame.setVisible(true);
   }
}
```

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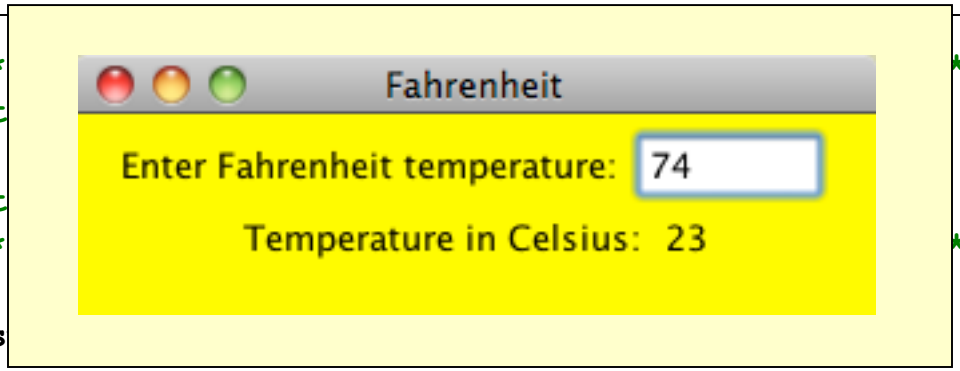


```
//************                                          **************
//  Fahrenheit
//
//  Demonstrat
//************                                          **************

import javax.s

public class Fahrenheit
{
   //-----------------------------------------------------------------
   //  Creates and displays the temperature converter GUI.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Fahrenheit");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      FahrenheitPanel panel = new FahrenheitPanel();

      frame.getContentPane().add(panel);
      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//********************************************************************
//  FahrenheitPanel.java       Author: Lewis/Loftus
//
//  Demonstrates the use of text fields.
//********************************************************************

import java.awt.*;
import java.awt.event.*;
import javax.swing.*;

public class FahrenheitPanel extends JPanel
{
   private JLabel inputLabel, outputLabel, resultLabel;
   private JTextField fahrenheit;

   //-----------------------------------------------------------------
   //  Constructor: Sets up the main GUI components.
   //-----------------------------------------------------------------
   public FahrenheitPanel()
   {
      inputLabel = new JLabel("Enter Fahrenheit temperature:");
      outputLabel = new JLabel("Temperature in Celsius: ");
      resultLabel = new JLabel("---");

      fahrenheit = new JTextField(5);
      fahrenheit.addActionListener(new TempListener());
```

continue

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continue

```
        add(inputLabel);
        add(fahrenheit);
        add(outputLabel);
        add(resultLabel);

        setPreferredSize(new Dimension(300, 75));
        setBackground(Color.yellow);
    }

    //*****************************************************************
    //  Represents an action listener for the temperature input field.
    //*****************************************************************
    private class TempListener implements ActionListener
    {
        //-----------------------------------------------------------
        //  Performs the conversion when the enter key is pressed in
        //  the text field.
        //-----------------------------------------------------------
        public void actionPerformed(ActionEvent event)
        {
            int fahrenheitTemp, celsiusTemp;

            String text = fahrenheit.getText();
```

continue

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continue

```
            fahrenheitTemp = Integer.parseInt(text);
            celsiusTemp = (fahrenheitTemp-32) * 5/9;

            resultLabel.setText(Integer.toString(celsiusTemp));
        }
    }
}
```

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Check Boxes

- A *check box* is a button that can be toggled on or off
- It is represented by the `JCheckBox` class
- Unlike a push button, which generates an action event, a check box generates an *item event* whenever it changes state
- The `ItemListener` interface is used to define item event listeners
- A check box calls the `itemStateChanged` method of the listener when it is toggled

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Check Boxes

- Let's examine a program that uses check boxes to determine the style of a label's text string
- It uses the `Font` class, which embodies a character font's:
  - family name (such as Times or Courier)
  - style (bold, italic, or both)
  - font size
- See `StyleOptions.java`
- See `StyleOptionsPanel.java`

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```
//********************************************************************
//  StyleOptions.java       Author: Lewis/Loftus
//
//  Demonstrates the use of check boxes.
//********************************************************************

import javax.swing.JFrame;

public class StyleOptions
{
   //-----------------------------------------------------------------
   //  Creates and presents the program frame.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Style Options");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      StyleOptionsPanel panel = new StyleOptionsPanel();
      frame.getContentPane().add(panel);

      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//*****************                                          *************
//  StyleOptions.
//
//  Demonstrates
//*****************                                          *************

import javax.swin

public class StyleOptions
{
   //-------------                                          -------------
   //  Creates an
   //-------------                                          -------------
   public static
   {
      JFrame fram
      frame.setDe                                                  SE);

      StyleOption
      frame.getContentPane().add(panel);

      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//********************************************************************
//  StyleOptionsPanel.java       Author: Lewis/Loftus
//
//  Demonstrates the use of check boxes.
//********************************************************************

import javax.swing.*;
import java.awt.*;
import java.awt.event.*;

public class StyleOptionsPanel extends JPanel
{
   private JLabel saying;
   private JCheckBox bold, italic;
```

continue

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continue

```
//-----------------------------------------------------------------
//  Sets up a panel with a label and some check boxes that
//  control the style of the label's font.
//-----------------------------------------------------------------
public StyleOptionsPanel()
{
   saying = new JLabel("Say it with style!");
   saying.setFont(new Font("Helvetica", Font.PLAIN, 36));

   bold = new JCheckBox("Bold");
   bold.setBackground(Color.cyan);
   italic = new JCheckBox("Italic");
   italic.setBackground(Color.cyan);

   StyleListener listener = new StyleListener();
   bold.addItemListener(listener);
   italic.addItemListener(listener);

   add(saying);
   add(bold);
   add(italic);

   setBackground(Color.cyan);
   setPreferredSize(new Dimension(300, 100));
}
```

continue

continue

```
   //*****************************************************************
   //  Represents the listener for both check boxes.
   //*****************************************************************
   private class StyleListener implements ItemListener
   {
      //--------------------------------------------------------------
      //  Updates the style of the label font style.
      //--------------------------------------------------------------
      public void itemStateChanged(ItemEvent event)
      {
         int style = Font.PLAIN;

         if (bold.isSelected())
            style = Font.BOLD;

         if (italic.isSelected())
            style += Font.ITALIC;

         saying.setFont(new Font("Helvetica", style, 36));
      }
   }
}
```

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Radio Buttons

- A group of *radio buttons* represents a set of mutually exclusive options – only one can be selected at any given time
- When a radio button from a group is selected, the button that is currently "on" in the group is automatically toggled off
- To define the group of radio buttons that will work together, each radio button is added to a `ButtonGroup` object
- A radio button generates an action event

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Radio Buttons

- Let's look at a program that uses radio buttons to determine which line of text to display

- See `QuoteOptions.java`
- See `QuoteOptionsPanel.java`

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```
//********************************************************************
//  QuoteOptions.java       Author: Lewis/Loftus
//
//  Demonstrates the use of radio buttons.
//********************************************************************

import javax.swing.JFrame;

public class QuoteOptions
{
   //-----------------------------------------------------------------
   //  Creates and presents the program frame.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Quote Options");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      QuoteOptionsPanel panel = new QuoteOptionsPanel();
      frame.getContentPane().add(panel);

      frame.pack();
      frame.setVisible(true);
   }
}
```

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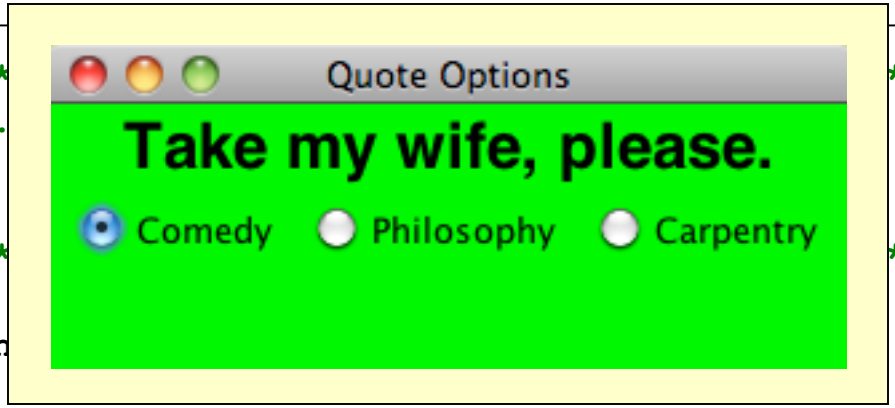

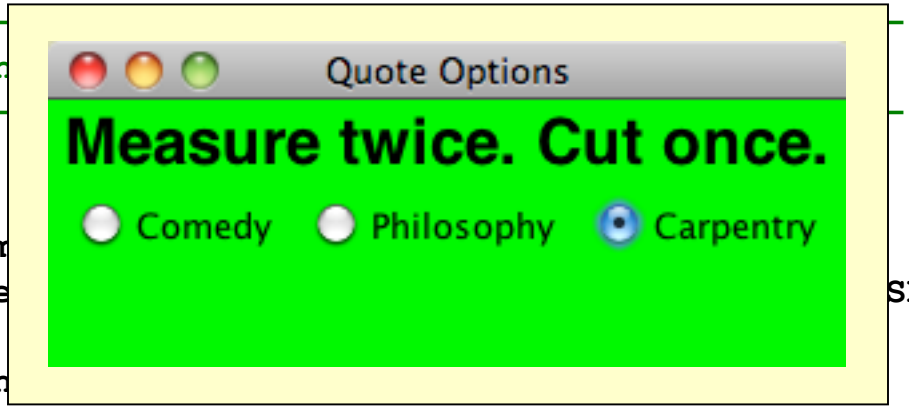


```
//*****************                                    *************
//  QuoteOptions.
//
//  Demonstrates
//*****************                                    *************

import javax.swin

public class QuoteOptions
{
   //-------------                                     -------------
   //  Creates an
   //-------------                                     -------------
   public static
   {
      JFrame fram
      frame.setDe                                          SE);

      QuoteOption
      frame.getContentPane().add(panel);

      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//********************************************************************
//  QuoteOptionsPanel.java       Author: Lewis/Loftus
//
//  Demonstrates the use of radio buttons.
//********************************************************************

import javax.swing.*;
import java.awt.*;
import java.awt.event.*;

public class QuoteOptionsPanel extends JPanel
{
   private JLabel quote;
   private JRadioButton comedy, philosophy, carpentry;
   private String comedyQuote, philosophyQuote, carpentryQuote;

   //-----------------------------------------------------------------
   //  Sets up a panel with a label and a set of radio buttons
   //  that control its text.
   //-----------------------------------------------------------------
   public QuoteOptionsPanel()
   {
      comedyQuote = "Take my wife, please.";
      philosophyQuote = "I think, therefore I am.";
      carpentryQuote = "Measure twice. Cut once.";

      quote = new JLabel(comedyQuote);
      quote.setFont(new Font("Helvetica", Font.BOLD, 24));
```

continue

continue

```
        comedy = new JRadioButton("Comedy", true);
        comedy.setBackground(Color.green);
        philosophy = new JRadioButton("Philosophy");
        philosophy.setBackground(Color.green);
        carpentry = new JRadioButton("Carpentry");
        carpentry.setBackground(Color.green);

        ButtonGroup group = new ButtonGroup();
        group.add(comedy);
        group.add(philosophy);
        group.add(carpentry);

        QuoteListener listener = new QuoteListener();
        comedy.addActionListener(listener);
        philosophy.addActionListener(listener);
        carpentry.addActionListener(listener);

        add(quote);
        add(comedy);
        add(philosophy);
        add(carpentry);

        setBackground(Color.green);
        setPreferredSize(new Dimension(300, 100));
    }
```

continue

continue

```
//*****************************************************************
//  Represents the listener for all radio buttons
//*****************************************************************
private class QuoteListener implements ActionListener
{
   //--------------------------------------------------------------
   //  Sets the text of the label depending on which radio
   //  button was pressed.
   //--------------------------------------------------------------
   public void actionPerformed(ActionEvent event)
   {
      Object source = event.getSource();

      if (source == comedy)
         quote.setText(comedyQuote);
      else
         if (source == philosophy)
            quote.setText(philosophyQuote);
         else
            quote.setText(carpentryQuote);
   }
}
}
```

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Drawing Techniques

- Conditionals and loops enhance our ability to generate interesting graphics

- See `Bullseye.java`
- See `BullseyePanel.java`

- See `Boxes.java`
- See `BoxesPanel.java`

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```
//********************************************************************
//  Bullseye.java       Author: Lewis/Loftus
//
//  Demonstrates the use of loops to draw.
//********************************************************************

import javax.swing.JFrame;

public class Bullseye
{
   //-----------------------------------------------------------------
   //  Creates the main frame of the program.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Bullseye");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      BullseyePanel panel = new BullseyePanel();

      frame.getContentPane().add(panel);
      frame.pack();
      frame.setVisible(true);
   }
}
```

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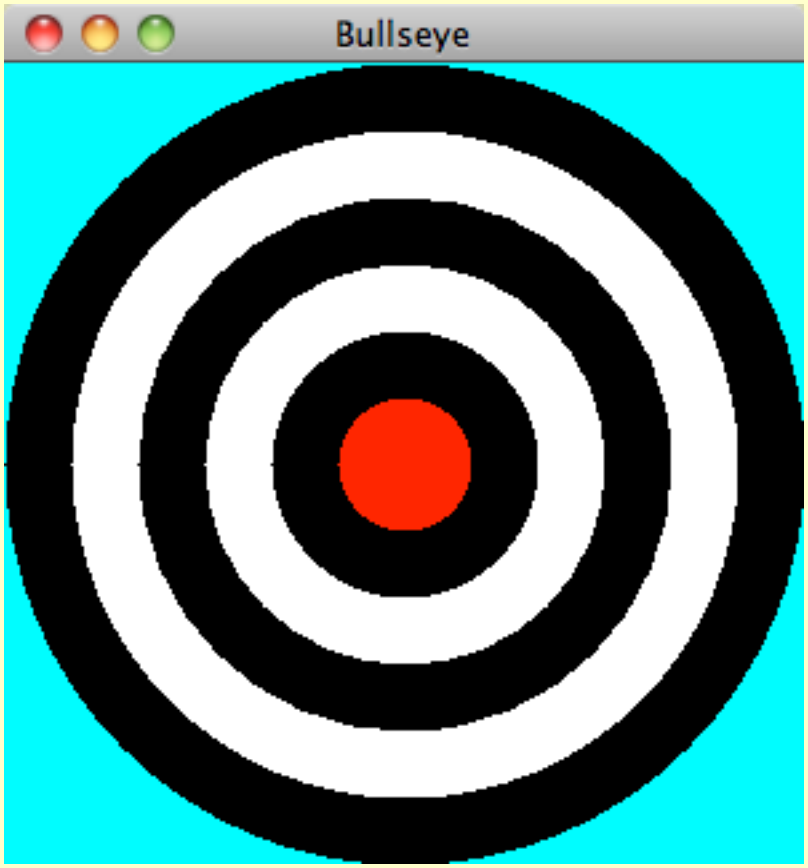


```
//*************                                          **************
//  Bullseye.j
//
//  Demonstrat
//*************                                          **************

import javax.s

public class B
{
   //---------                                          --------------
   //  Creates
   //---------                                          --------------
   public stat
   {
      JFrame f
      frame.se                                          OSE);

      Bullseye

      frame.getContentPane().add(panel);
      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//********************************************************************
//  BullseyePanel.java       Author: Lewis/Loftus
//
//  Demonstrates the use of conditionals and loops to guide drawing.
//********************************************************************

import javax.swing.JPanel;
import java.awt.*;

public class BullseyePanel extends JPanel
{
   private final int MAX_WIDTH = 300, NUM_RINGS = 5, RING_WIDTH = 25;

   //-----------------------------------------------------------------
   //  Sets up the bullseye panel.
   //-----------------------------------------------------------------
   public BullseyePanel()
   {
      setBackground(Color.cyan);
      setPreferredSize(new Dimension(300,300));
   }
```

continue

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continue

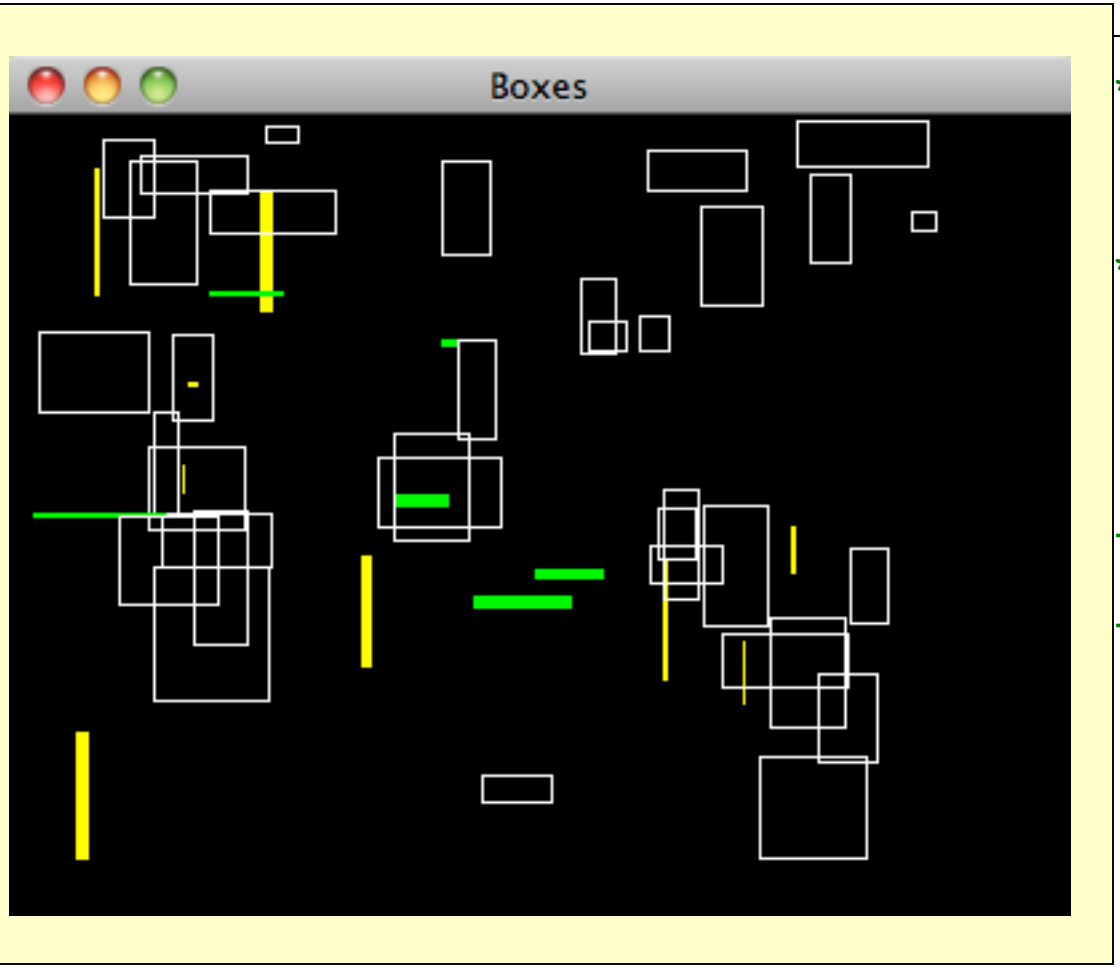
```
    //-----------------------------------------------------------------
    //  Paints a bullseye target.
    //-----------------------------------------------------------------
    public void paintComponent(Graphics page)
    {
        super.paintComponent (page);
        int x = 0, y = 0, diameter = MAX_WIDTH;
        page.setColor(Color.white);

        for (int count = 0; count < NUM_RINGS; count++)
        {
            if (page.getColor() == Color.black)  // alternate colors
                page.setColor(Color.white);
            else
                page.setColor Color.black);

            page.fillOval(x, y, diameter, diameter);

            diameter -= (2 * RING_WIDTH);
            x += RING_WIDTH;
            y += RING_WIDTH;
        }

        // Draw the red bullseye in the center
        page.setColor(Color.red);
        page.fillOval(x, y, diameter, diameter);
    }
}
```




```
//*********                                                    ********
//  Boxes.j
//
//  Demonst
//*********                                                    ********

import java

public clas
{
   //------                                                    --------
   //  Crea
   //------                                                    --------
   public s
   {
      JFrar
      frame

      Boxes

      frame.getContentPane().add(panel);
      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//********************************************************************
//  BoxesPanel.java       Author: Lewis/Loftus
//
//  Demonstrates the use of conditionals and loops to guide drawing.
//********************************************************************

import javax.swing.JPanel;
import java.awt.*;
import java.util.Random;

public class BoxesPanel extends JPanel
{
   private final int NUM_BOXES = 50, THICKNESS = 5, MAX_SIDE = 50;
   private final int MAX_X = 350, MAX_Y = 250;
   private Random generator;

   //-----------------------------------------------------------------
   //  Sets up the drawing panel.
   //-----------------------------------------------------------------
   public BoxesPanel()
   {
      generator = new Random();

      setBackground(Color.black);
      setPreferredSize(new Dimension(400, 300));
   }
```

continue

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continue

```
//-----------------------------------------------------------------
//  Paints boxes of random width and height in a random location.
//  Narrow or short boxes are highlighted with a fill color.
//-----------------------------------------------------------------
public void paintComponent(Graphics page)
{
   super.paintComponent(page);

   int x, y, width, height;

   for (int count = 0; count < NUM_BOXES; count++)
   {
      x = generator.nextInt(MAX_X) + 1;
      y = generator.nextInt(MAX_Y) + 1;

      width = generator.nextInt(MAX_SIDE) + 1;
      height = generator.nextInt(MAX_SIDE) + 1;
```

continue

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continue

```
            if (width <= THICKNESS)  // check for narrow box
            {
               page.setColor(Color.yellow);
               page.fillRect(x, y, width, height);
            }
            else
               if (height <= THICKNESS)  // check for short box
               {
                  page.setColor(Color.green);
                  page.fillRect(x, y, width, height);
               }
               else
               {
                  page.setColor(Color.white);
                  page.drawRect(x, y, width, height);
               }
         }
      }
   }
```

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Outline

- The `switch` Statement
- The Conditional Operator
- The `do` Statement
- The `for` Statement
- Drawing with Loops and Conditionals
- Dialog Boxes

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Dialog Boxes

- A *dialog box* is a window that appears on top of any currently active window
- It may be used to:
  - convey information
  - confirm an action
  - allow the user to enter data
  - pick a color
  - choose a file
- A dialog box usually has a specific, solitary purpose, and the user interaction with it is brief

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Dialog Boxes

- The `JOptionPane` class provides methods that simplify the creation of some types of dialog boxes
- See `EvenOdd.java`
- Specialized dialog boxes for choosing colors and files are covered in Chapter 9

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```
/********************************************************************
//  EvenOdd.java       Author: Lewis/Loftus
//
//  Demonstrates the use of the JOptionPane class.
//********************************************************************

import javax.swing.JOptionPane;

public class EvenOdd
{
   //-----------------------------------------------------------------
   //  Determines if the value input by the user is even or odd.
   //  Uses multiple dialog boxes for user interaction.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      String numStr, result;
      int num, again;
```

continue

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continue

```
        do
        {
            numStr = JOptionPane.showInputDialog("Enter an integer: ");
            num = Integer.parseInt(numStr);

            result = "That number is " + ((num%2 == 0) ? "even" : "odd");

            JOptionPane.showMessageDialog(null, result);
            again = JOptionPane.showConfirmDialog(null, "Do Another?");
        }
        while (again == JOptionPane.YES_OPTION);
    }
}
```

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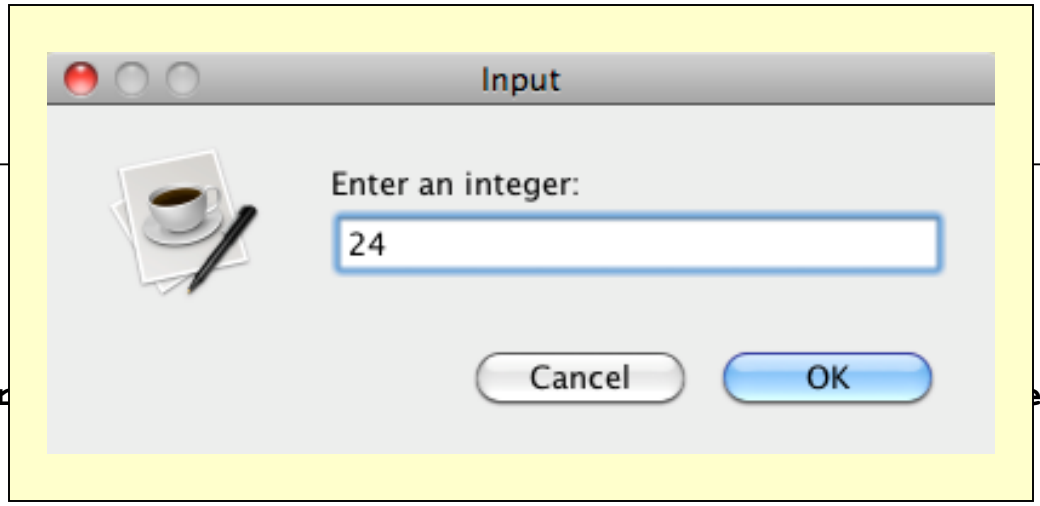
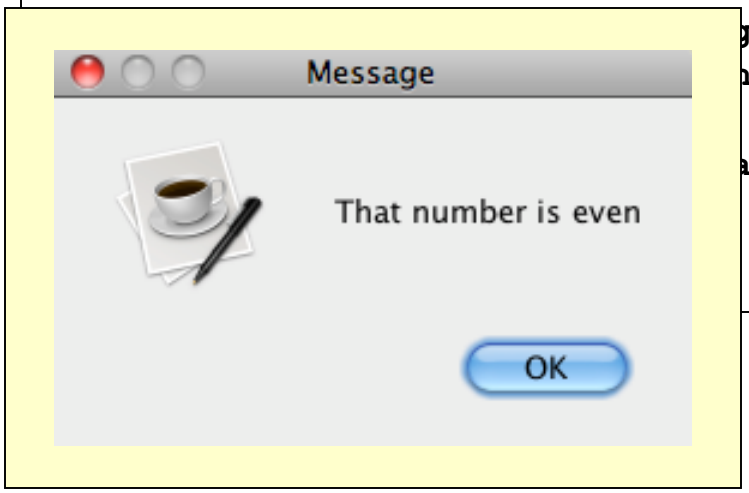
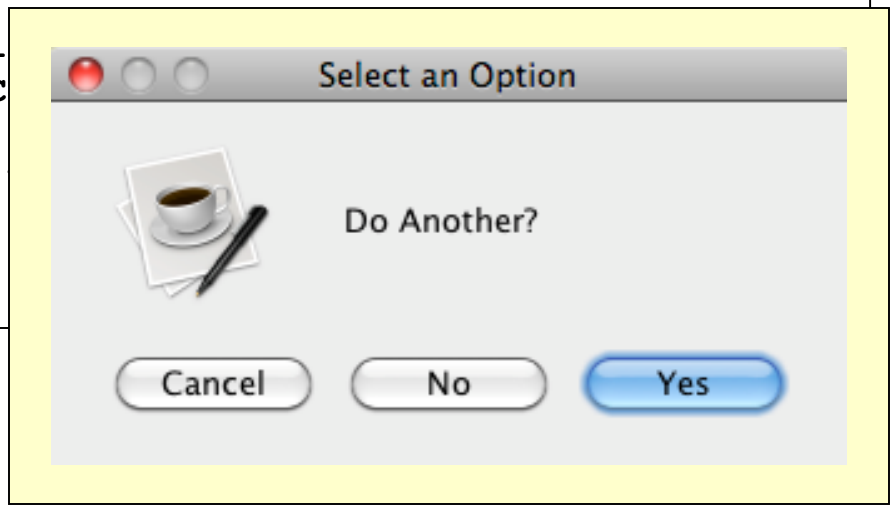
continue

```
do
{
    numStr                                          eger: ");
    num =

    result = "That number is " + ((num%2 == 0) ? "even" : "odd");
```







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GUI Design

- We must remember that the goal of software is to help the user solve the problem
- To that end, the GUI designer should:
  - Know the user
  - Prevent user errors
  - Optimize user abilities
  - Be consistent
- Let's discuss each of these in more detail

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Know the User

- Knowing the user implies an understanding of:
  - the user's true needs
  - the user's common activities
  - the user's level of expertise in the problem domain and in computer processing
- We should also realize these issues may differ for different users
- Remember, to the user, the interface is the program

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Prevent User Errors

- Whenever possible, we should design user interfaces that minimize possible user mistakes
- We should choose the best GUI components for each task
- For example, in a situation where there are only a few valid options, using a menu or radio buttons would be better than an open text field
- Error messages should guide the user appropriately

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Optimize User Abilities

- Not all users are alike – some may be more familiar with the system than others
- Knowledgeable users are sometimes called *power users*
- We should provide multiple ways to accomplish a task whenever reasonable
  - "wizards" to walk a user through a process
  - short cuts for power users
- Help facilities should be available but not intrusive

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Be Consistent

- Consistency is important – users get used to things appearing and working in certain ways
- Colors should be used consistently to indicate similar types of information or processing
- Screen layout should be consistent from one part of a system to another
- For example, error messages should appear in consistent locations

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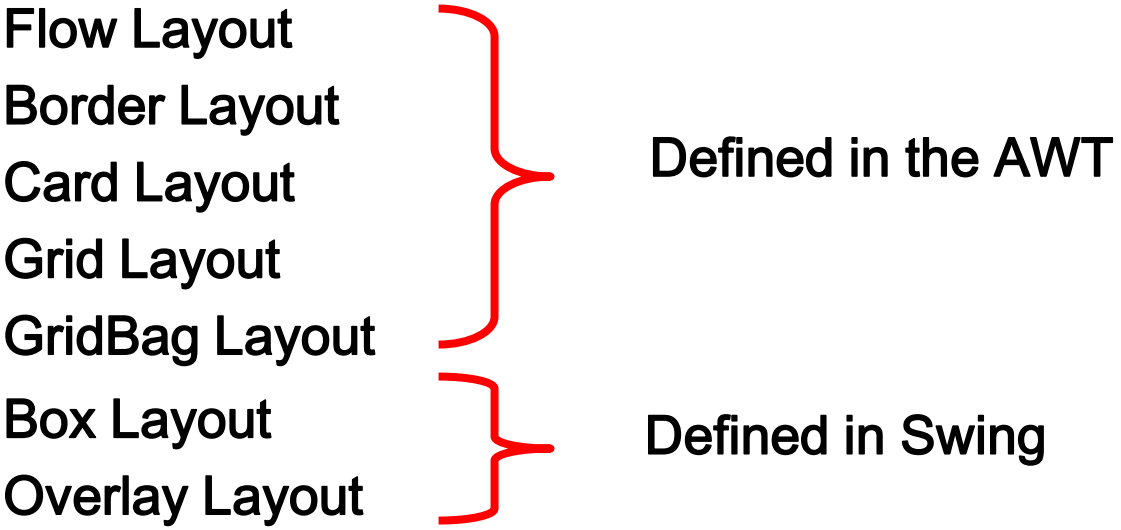
Layout Managers

- A *layout manager* is an object that determines the way that components are arranged in a container

- There are several predefined layout managers defined in the Java API:



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Layout Managers

- Every container has a default layout manager, but we can explicitly set the layout manager as well
- Each layout manager has its own particular rules governing how the components will be arranged
- Some layout managers pay attention to a component's preferred size or alignment, while others do not
- A layout manager adjusts the layout as components are added and as containers are resized

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Layout Managers

- We can use the `setLayout` method of a container to change its layout manager:

```
JPanel panel = new JPanel();
panel.setLayout(new BorderLayout());
```

- The following example uses a *tabbed pane*, a container which permits one of several panes to be selected

- See `LayoutDemo.java`
- See `IntroPanel.java`

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```
//********************************************************************
//  LayoutDemo.java       Authors: Lewis/Loftus
//
//  Demonstrates the use of flow, border, grid, and box layouts.
//********************************************************************

import javax.swing.*;

public class LayoutDemo
{
   //-----------------------------------------------------------------
   //  Sets up a frame containing a tabbed pane. The panel on each
   //  tab demonstrates a different layout manager.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Layout Manager Demo");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
```

continue

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continue

```
        JTabbedPane tp = new JTabbedPane();
        tp.addTab("Intro", new IntroPanel());
        tp.addTab("Flow", new FlowPanel());
        tp.addTab("Border", new BorderPanel());
        tp.addTab("Grid", new GridPanel());
        tp.addTab("Box", new BoxPanel());

        frame.getContentPane().add(tp);
        frame.pack();
        frame.setVisible(true);
    }
}
```

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```
//********************************************************************
//  IntroPanel.java       Authors: Lewis/Loftus
//
//  Represents the introduction panel for the LayoutDemo program.
//********************************************************************

import java.awt.*;
import javax.swing.*;

public class IntroPanel extends JPanel
{
   //-----------------------------------------------------------------
   //  Sets up this panel with two labels.
   //-----------------------------------------------------------------
   public IntroPanel()
   {
      setBackground(Color.green);

      JLabel l1 = new JLabel("Layout Manager Demonstration");
      JLabel l2 = new JLabel("Choose a tab to see an example of " +
                             "a layout manager.");

      add(l1);
      add(l2);
   }
}
```

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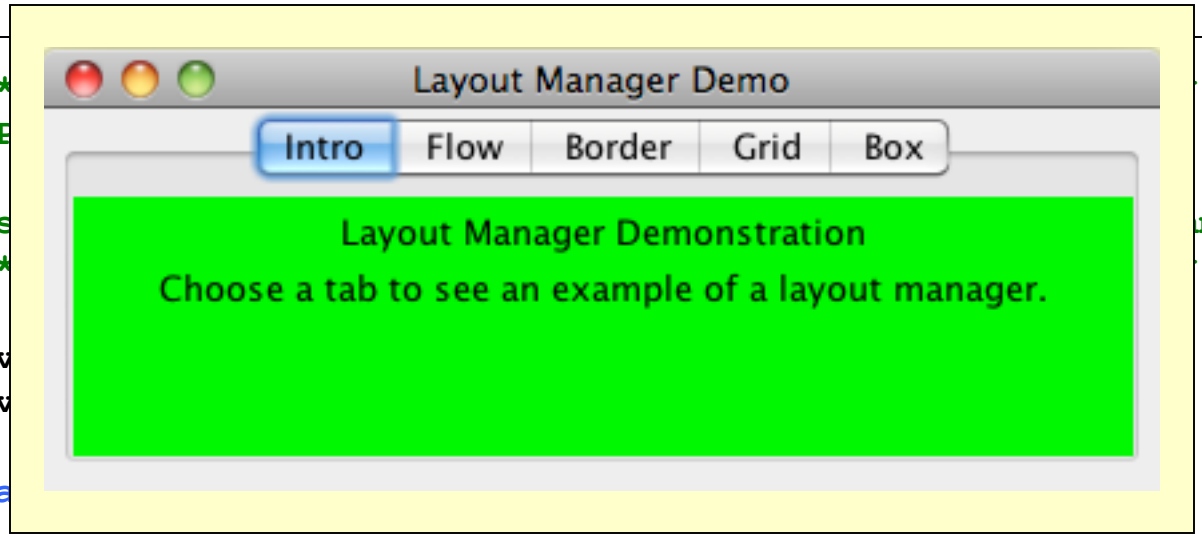


```
//********
//  IntroP                                                    *******
//
//  Repres                                                    m.
//********                                                   *******

import jav
import jav

public cla
{
   //-----------------------------------------------------------------
   //  Sets up this panel with two labels.
   //-----------------------------------------------------------------
   public IntroPanel()
   {
      setBackground(Color.green);

      JLabel l1 = new JLabel("Layout Manager Demonstration");
      JLabel l2 = new JLabel("Choose a tab to see an example of " +
                             "a layout manager.");

      add(l1);
      add(l2);
   }
}
```

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Flow Layout

- *Flow layout* puts as many components as possible on a row, then moves to the next row
- Components are displayed in the order they are added to the container
- Each row of components is centered horizontally by default, but could also be aligned left or right
- The horizontal and vertical gaps between the components can be explicitly set
- See `FlowPanel.java`

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```
//********************************************************************
//  FlowPanel.java       Authors: Lewis/Loftus
//
//  Represents the panel in the LayoutDemo program that demonstrates
//  the flow layout manager.
//********************************************************************

import java.awt.*;
import javax.swing.*;

public class FlowPanel extends JPanel
{
   //-----------------------------------------------------------------
   //  Sets up this panel with some buttons to show how flow layout
   //  affects their position.
   //-----------------------------------------------------------------
   public FlowPanel()
   {
      setLayout(new FlowLayout());

      setBackground(Color.green);
```

continue

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continue

```
        JButton b1 = new JButton("BUTTON 1");
        JButton b2 = new JButton("BUTTON 2");
        JButton b3 = new JButton("BUTTON 3");
        JButton b4 = new JButton("BUTTON 4");
        JButton b5 = new JButton("BUTTON 5");

        add(b1);
        add(b2);
        add(b3);
        add(b4);
        add(b5);
    }
}
```

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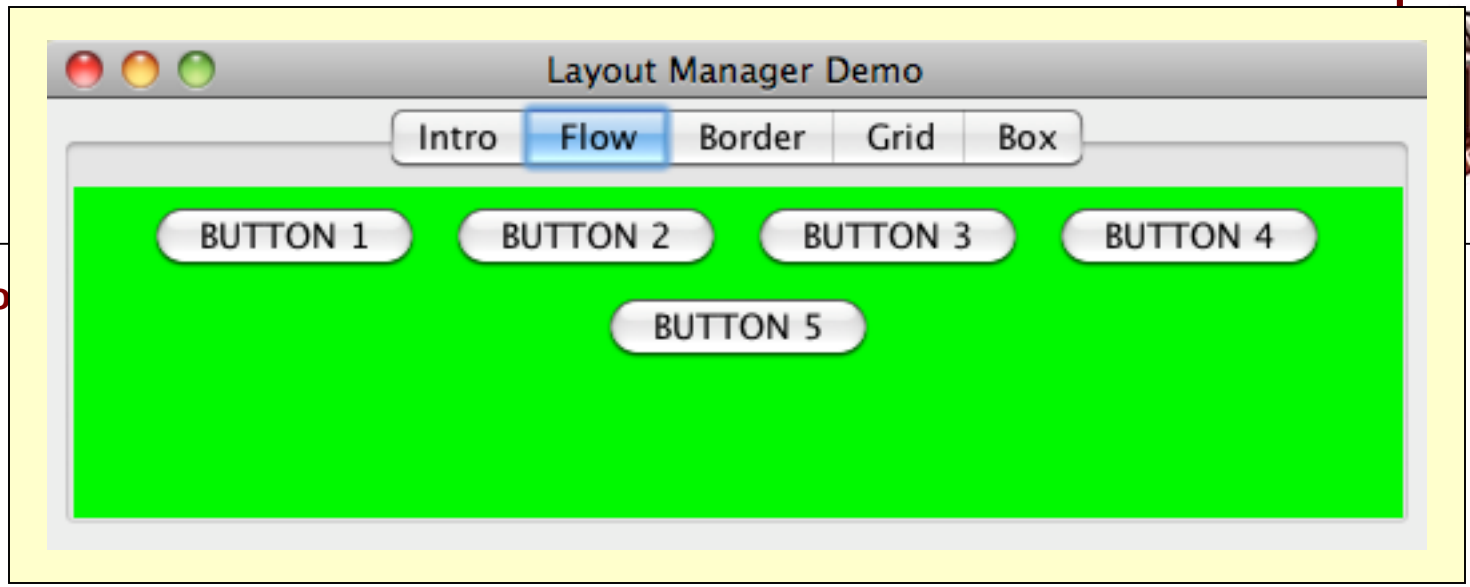
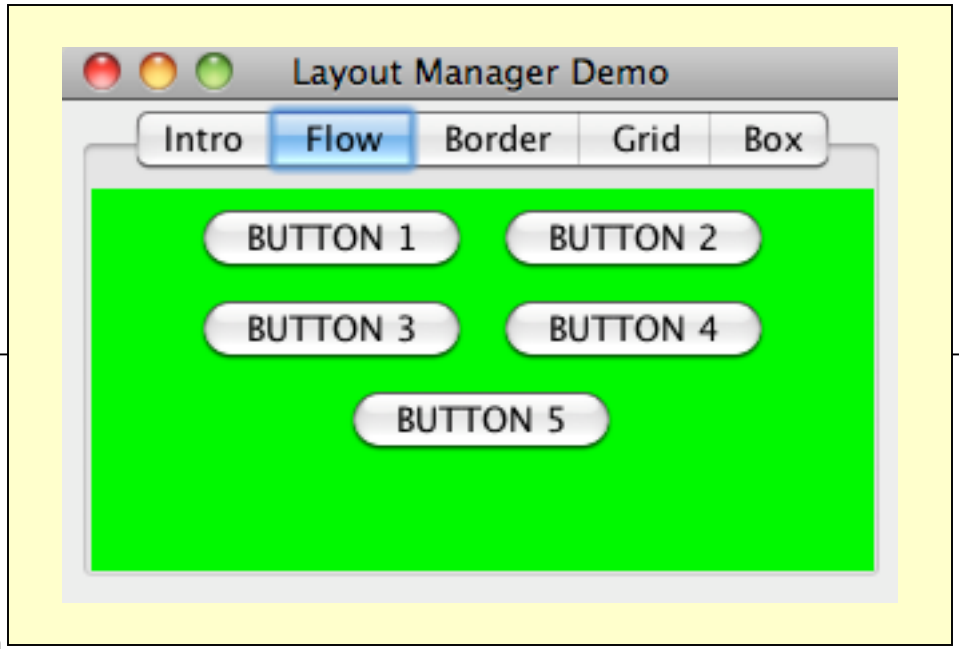



```
co
        add(b1)
        add(b2)
        add(b3)
        add(b4)
        add(b5)
    }
}
```



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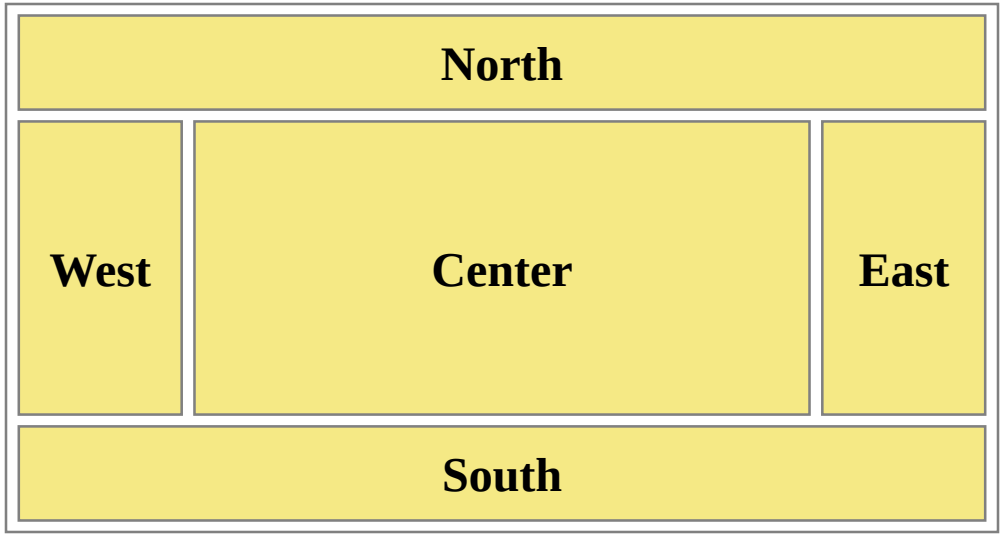
Border Layout

- A *border layout* defines five areas into which components can be added



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Border Layout

- Each area displays one component (which could be a container such as a `JPanel`)
- Each of the four outer areas enlarges as needed to accommodate the component added to it
- If nothing is added to the outer areas, they take up no space and other areas expand to fill the void
- The center area expands to fill space as needed
- See `BorderPanel.java`

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```
//********************************************************************
//  BorderPanel.java       Authors: Lewis/Loftus
//
//  Represents the panel in the LayoutDemo program that demonstrates
//  the border layout manager.
//********************************************************************

import java.awt.*;
import javax.swing.*;

public class BorderPanel extends JPanel
{
   //-----------------------------------------------------------------
   //  Sets up this panel with a button in each area of a border
   //  layout to show how it affects their position, shape, and size.
   //-----------------------------------------------------------------
   public BorderPanel()
   {
      setLayout(new BorderLayout());

      setBackground(Color.green);
```

continue

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continue

```
        JButton b1 = new JButton("BUTTON 1");
        JButton b2 = new JButton("BUTTON 2");
        JButton b3 = new JButton("BUTTON 3");
        JButton b4 = new JButton("BUTTON 4");
        JButton b5 = new JButton("BUTTON 5");

        add(b1, BorderLayout.CENTER);
        add(b2, BorderLayout.NORTH);
        add(b3, BorderLayout.SOUTH);
        add(b4, BorderLayout.EAST);
        add(b5, BorderLayout.WEST);
    }
}
```

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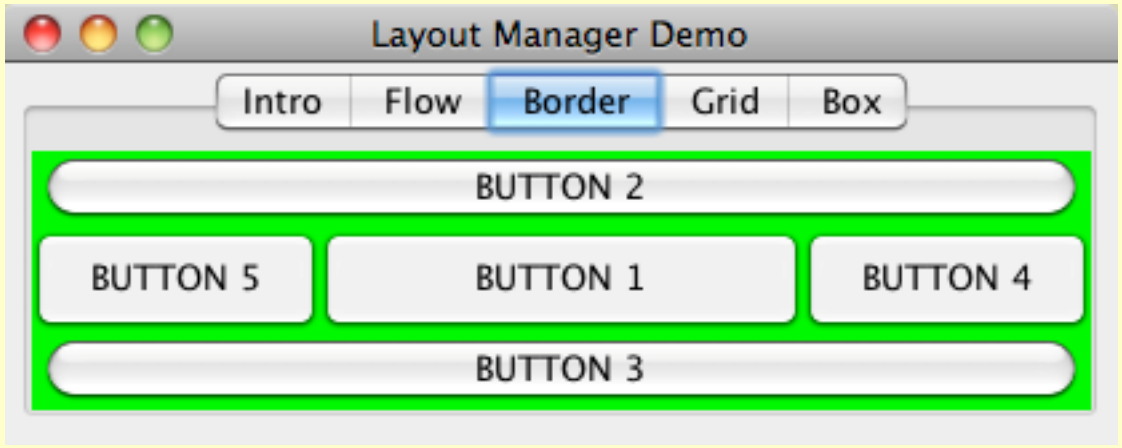
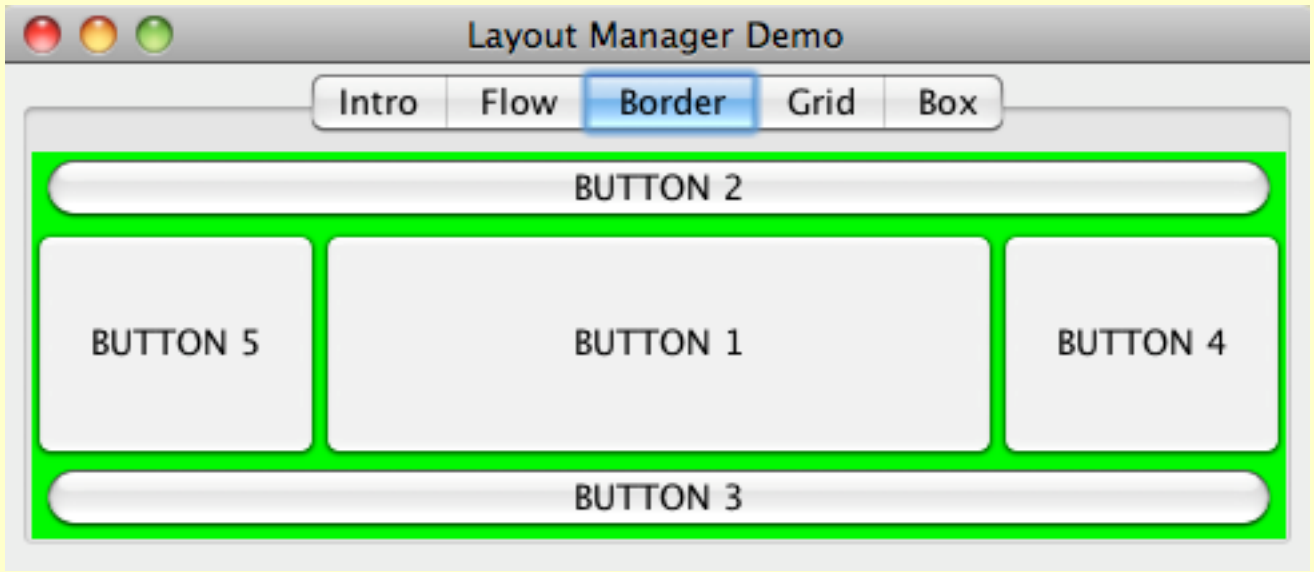


continue

```
        JBu
        JBu
        JBu
        JButton b4 = new JButton("BUTTON 4");
        JButton b5 = new JButton("BUTTON 5");
```




```
    }
}
```

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Grid Layout

- A *grid layout* presents a container's components in a rectangular grid of rows and columns
- One component is placed in each cell of the grid, and all cells have the same size
- Components fill the grid from left-to-right and top-to-bottom (by default)
- The size of each cell is determined by the overall size of the container
- See `GridPanel.java`

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```
//********************************************************************
//  GridPanel.java       Authors: Lewis/Loftus
//
//  Represents the panel in the LayoutDemo program that demonstrates
//  the grid layout manager.
//********************************************************************

import java.awt.*;
import javax.swing.*;

public class GridPanel extends JPanel
{
   //-----------------------------------------------------------------
   //  Sets up this panel with some buttons to show how grid
   //  layout affects their position, shape, and size.
   //-----------------------------------------------------------------
   public GridPanel()
   {
      setLayout(new GridLayout(2, 3));

      setBackground(Color.green);
```

continue

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continue

```
        JButton b1 = new JButton("BUTTON 1");
        JButton b2 = new JButton("BUTTON 2");
        JButton b3 = new JButton("BUTTON 3");
        JButton b4 = new JButton("BUTTON 4");
        JButton b5 = new JButton("BUTTON 5");

        add(b1);
        add(b2);
        add(b3);
        add(b4);
        add(b5);
    }
}
```

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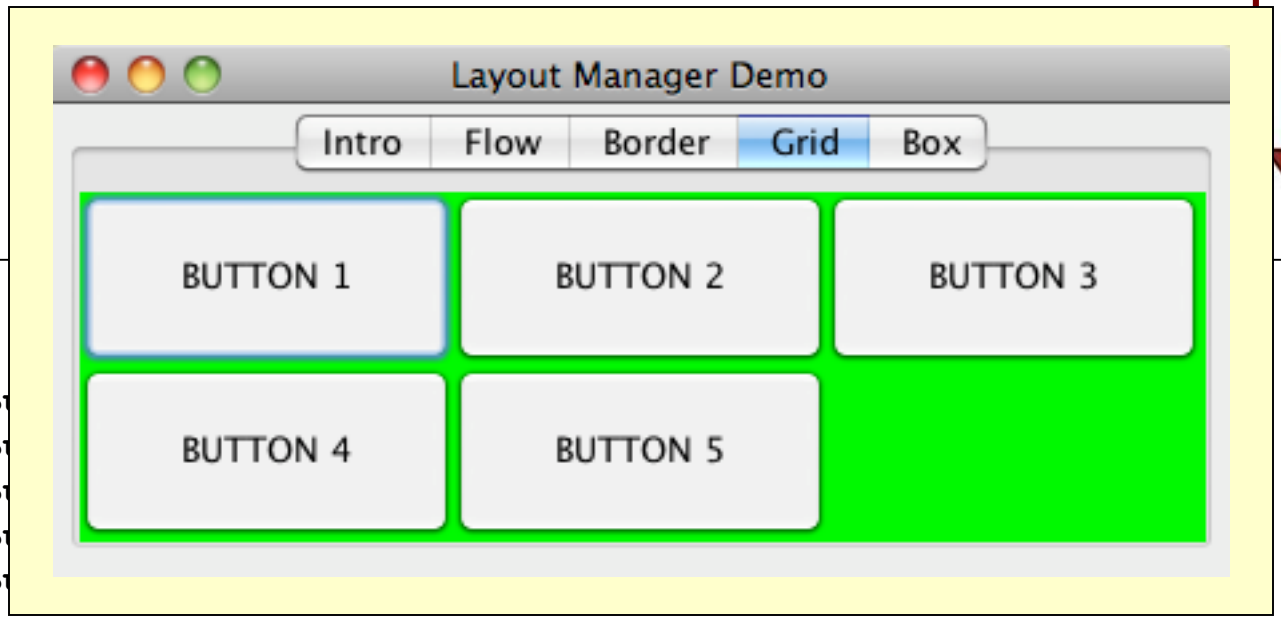
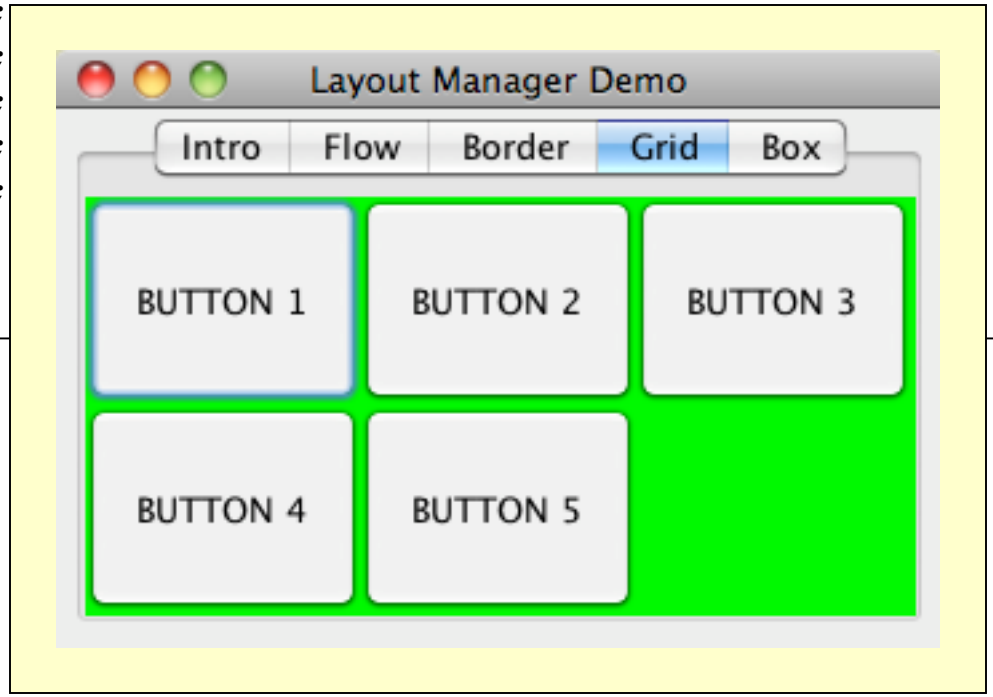


continue

```
        JBu
        JBu
        JBu
        JBu
        JBu

        add(b1);
        add(b2);
        add(b3);
        add(b4);
        add(b5);
    }
}
```



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Box Layout

- A *box layout* organizes components horizontally (in one row) or vertically (in one column)
- Components are placed top-to-bottom or left-to-right in the order in which they are added to the container
- By combining multiple containers using box layout, many different configurations can be created
- Multiple containers with box layouts are often preferred to one container that uses the more complicated gridbag layout manager

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Box Layout

- *Invisible components* can be added to a box layout container to take up space between components
  - *Rigid areas* have a fixed size
  - *Glue* specifies where excess space should go
- Invisible components are created using these methods of the `Box` class:

```
createRigidArea(Dimension d)
createHorizontalGlue()
createVerticalGlue()
```

- See `BoxPanel.java`

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```
//********************************************************************
//  BoxPanel.java       Authors: Lewis/Loftus
//
//  Represents the panel in the LayoutDemo program that demonstrates
//  the box layout manager.
//********************************************************************

import java.awt.*;
import javax.swing.*;

public class BoxPanel extends JPanel
{
   //-----------------------------------------------------------------
   //  Sets up this panel with some buttons to show how a vertical
   //  box layout (and invisible components) affects their position.
   //-----------------------------------------------------------------
   public BoxPanel()
   {
      setLayout(new BoxLayout(this, BoxLayout.Y_AXIS));

      setBackground(Color.green);
```

continue

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continue

```
        JButton b1 = new JButton("BUTTON 1");
        JButton b2 = new JButton("BUTTON 2");
        JButton b3 = new JButton("BUTTON 3");
        JButton b4 = new JButton("BUTTON 4");
        JButton b5 = new JButton("BUTTON 5");

        add(b1);
        add(Box.createRigidArea(new Dimension(0, 10)));
        add(b2);
        add(Box.createVerticalGlue());
        add(b3);
        add(b4);
        add(Box.createRigidArea(new Dimension(0, 20)));
        add(b5);
    }
}
```

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continue

```
            JBu                                                    UT"
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            JBu                                                    UT"
            JBu                                                    UT"
            JBu                                                    UT"

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            ado
            ado                                                    w
            ado
        }
}
```

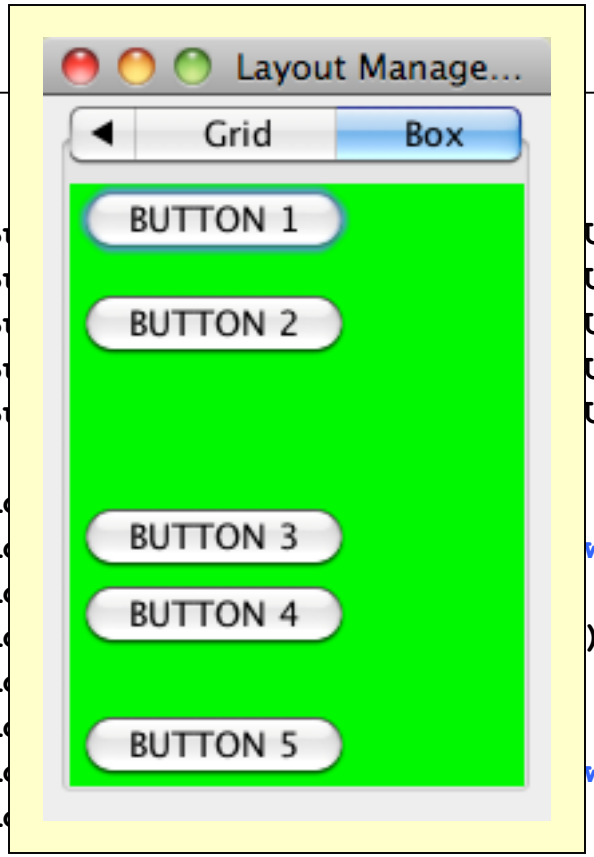

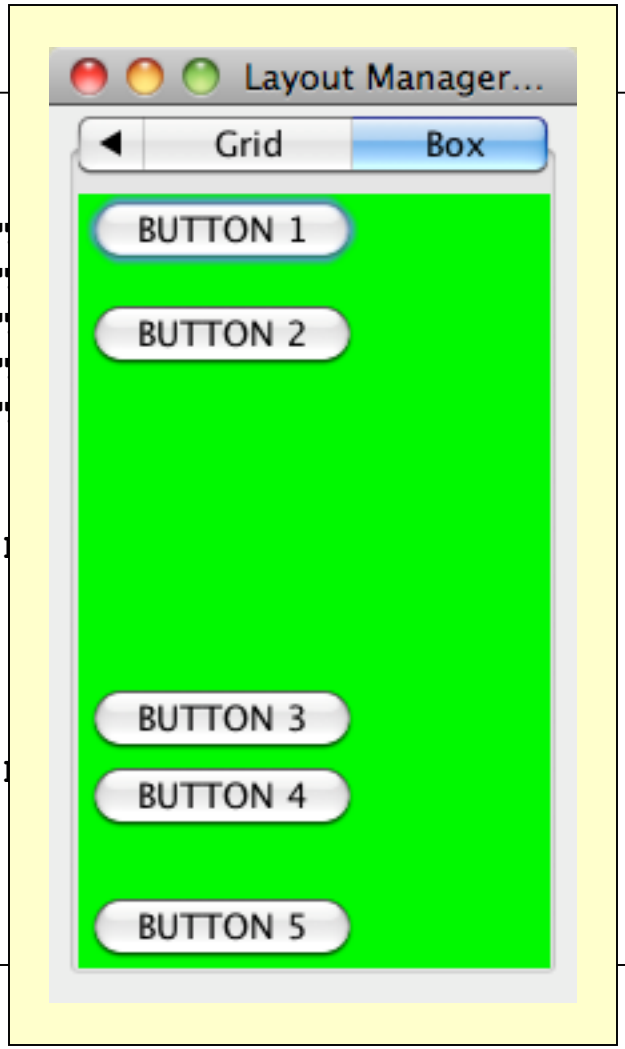

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Borders

- A *border* can be put around any Swing component to define how the edges of the component should be drawn
- Borders can be used effectively to group components visually
- The `BorderFactory` class contains several static methods for creating border objects
- A border is applied to a component using the `setBorder` method

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Borders

- An *empty border*
  - buffers the space around the edge of a component
  - otherwise has no visual effect
- A *line border*
  - surrounds the component with a simple line
  - the line's color and thickness can be specified
- An *etched border*
  - creates the effect of an etched groove around a component
  - uses colors for the highlight and shadow

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Borders

- A *bevel border*
  - can be raised or lowered
  - uses colors for the outer and inner highlights and shadows
- A *titled border*
  - places a title on or around the border
  - the title can be oriented in many ways
- A *matte border*
  - specifies the sizes of the top, left, bottom, and right edges of the border separately
  - uses either a solid color or an image

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Borders

- A *compound border*
  - is a combination of two borders
  - one or both of the borders can be a compound border
- See `BorderDemo.java`

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```
//*****************************************************************
//  BorderDemo.java       Authors: Lewis/Loftus
//
//  Demonstrates the use of various types of borders.
//*****************************************************************

import java.awt.*;
import javax.swing.*;
import javax.swing.border.*;

public class BorderDemo
{
   //--------------------------------------------------------------
   //  Creates several bordered panels and displays them.
   //--------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Border Demo");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      JPanel panel = new JPanel();
      panel.setLayout(new GridLayout(0, 2, 5, 10));
      panel.setBorder(BorderFactory.createEmptyBorder(8, 8, 8, 8));

      JPanel p1 = new JPanel();
      p1.setBorder(BorderFactory.createLineBorder(Color.red, 3));
      p1.add(new JLabel("Line Border"));
      panel.add(p1);
```

continue

continue

```
JPanel p2 = new JPanel();
p2.setBorder(BorderFactory.createEtchedBorder());
p2.add(new JLabel("Etched Border"));
panel.add(p2);

JPanel p3 = new JPanel();
p3.setBorder(BorderFactory.createRaisedBevelBorder());
p3.add(new JLabel("Raised Bevel Border"));
panel.add(p3);

JPanel p4 = new JPanel();
p4.setBorder(BorderFactory.createLoweredBevelBorder());
p4.add(new JLabel("Lowered Bevel Border"));
panel.add(p4);

JPanel p5 = new JPanel();
p5.setBorder(BorderFactory.createTitledBorder("Title"));
p5.add(new JLabel("Titled Border"));
panel.add(p5);

JPanel p6 = new JPanel();
TitledBorder tb = BorderFactory.createTitledBorder("Title");
tb.setTitleJustification(TitledBorder.RIGHT);
p6.setBorder(tb);
p6.add(new JLabel("Titled Border(right)"));
panel.add(p6);
```

continue

continue

```
        JPanel p7 = new JPanel();
        Border b1 = BorderFactory.createLineBorder(Color.blue, 2);
        Border b2 = BorderFactory.createEtchedBorder();
        p7.setBorder (BorderFactory.createCompoundBorder(b1, b2));
        p7.add (new JLabel("Compound Border"));
        panel.add(p7);

        JPanel p8 = new JPanel();
        Border mb = BorderFactory.createMatteBorder(1, 5, 1, 1,
                                                    Color.red);
        p8.setBorder(mb);
        p8.add(new JLabel("Matte Border"));
        panel.add(p8);

        frame.getContentPane().add(panel);
        frame.pack();
        frame.setVisible(true);
    }
}
```

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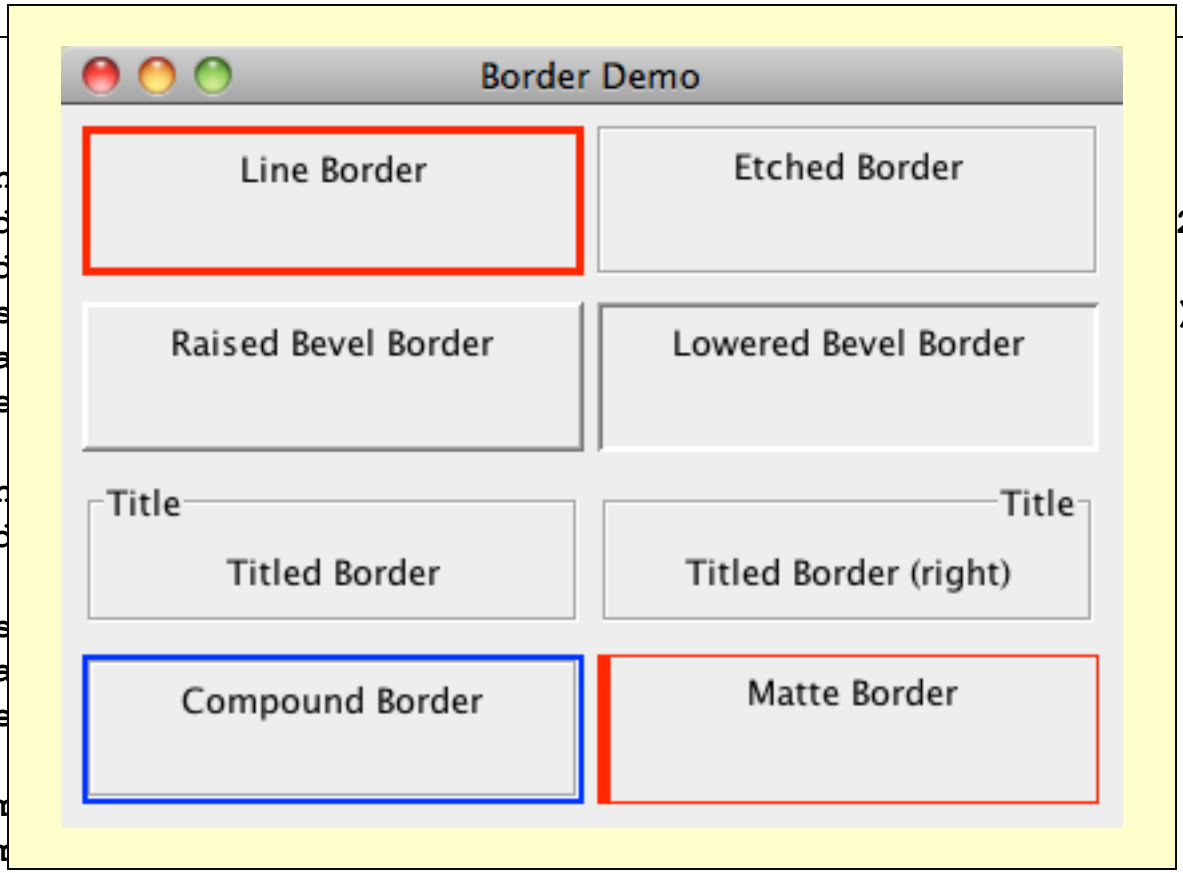
continue

```
        JPar
        Bord                                                    2);
        Bord
        p7.s                                                    ));
        p7.a
        pane

        JPar
        Bord

        p8.s
        p8.a
        pane

        fram
        fram
        frame.setVisible(true);
    }
}
```



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